CLAIMS

1. A method of generating plasma in a toroidal plasma generator, said toroidal plasma generator comprising a gas passage having a gas entrance and a gas outlet, said gas passage forming a circuitous path, and a coil wound around a part of the gas passage,

characterized in that said method comprises the steps of supplying a mixed gas of an Ar gas and an NF_3 gas containing at least 5% of said NF_3 gas, and igniting plasma by driving said coil with a high-frequency power,

said step of igniting plasma being conducted under a total pressure of 6.65-66.5Pa.

2. The method of generating plasma as claimed in claim 1, characterized in that said mixed gas contains NF_3 by a concentration of 5% or more but not exceeding 45% in said plasma ignition step.

3. The method of generating plasma as claimed in claim 1, characterized in that said mixed gas in said plasma ignition step contains NF_3 with a

concentration of 10% or more but not exceeding 45% in said plasma ignition step.

4. The method of generating plasma as claimed in claim 1, characterized in that said mixed gas contains NF_3 with a concentration of 20% or more but not exceeding 45% in said plasma ignition step.

5. The method of generating plasma as claimed in claim 1, characterized in that said method further comprises, after said step of igniting plasma, a step of increasing a total pressure of said mixed gas.

6. The method of generating plasma as claimed in claim 5, characterized in that said step of increasing said total pressure of said mixed gas is conducted while maintaining said concentration of NF_3 in said mixed gas at constant.

7. The method of generating plasma as

claimed in claim 5, characterized in that said step of increasing the total pressure of said mixed gas is conducted while changing said concentration of NF_3 in said mixed gas.

8. The method of generating plasma as claimed in claim 5, characterized in that said mixed gas contains NF_3, after said step of increasing said total pressure of said mixed gas, with a concentration of 5 - 40%.

9. The method of generating plasma as claimed in claim 1, characterized in that said mixed gas is supplied with a flow rate of 100SCCM or less in said plasma ignition step.

10. The method of generating plasma as claimed in claim 1, characterized in that said mixed gas is supplied with a flow rate of 3SCCM or more but not exceeding 80SCCM.

11. A method of generating plasma in a toroidal plasma generator, said toroidal plasma generator comprising a gas passage having a gas entrance and a gas outlet, said gas passage forming a circuitous path, and a coil would around a part of said gas passage,

characterized in that said method comprises the steps of supplying a mixed gas of an Ar gas and a F_2 gas containing at least 5% of said F_2 gas, and igniting plasma by driving said coil with a high-frequency power,

said step of igniting plasma being conducted under a total pressure of 6.65-66.5Pa.

12. The method of generating plasma as claimed in claim 11, characterized in that said mixed gas contains F_2 with a concentration of 5% or more but not exceeding 45%.

13. The method of generating plasma as claimed in claim 11, characterized in that said method further comprises, after said ignition step, a step of increasing a total pressure of said mixed gas.

14. The method of generating plasma as claimed in claim 13, characterized in that said step of increasing said total pressure of said mixed gas is conducted while maintaining said concentration of F_2 in said mixed gas at constant.

15. The method of generating plasma as claimed in claim 13, characterized in that said step of increasing said total pressure of said mixed gas is conducted while changing said concentration of F_2 in said mixed gas.

16. The method of generating plasma as claimed in claim 11, characterized in that said mixed gas is supplied with a flow rate of 100SCCM or less in said plasma ignition step.

17. A cleaning method for cleaning a processing vessel evacuated by an evacuating system and coupled with a remote plasma source,

said remote plasma source comprising a toroidal plasma generator, said toroidal plasma generator comprising a gas passage having a gas entrance and a gas outlet, said gas passage forming a

circuitous path, and a coil would around a part of said gas passage,

characterized in that said cleaning method comprises the steps of:

forming radicals containing F in said remote plasma source; and

supplying said radicals to an interior of said processing vessel and cleaning said interior of said processing vessel by said radicals,

said step of forming said radicals comprising the steps of:

supplying a mixed gas containing at least 5% of NF_3 or F_2 in an Ar gas to said gas passage as a cleaning gas with a first pressure in which plasma can ignite and igniting plasma by driving said coil by a high-frequency power; and

increasing a total pressure of said mixed gas in said gas passage to a second pressure while maintaining said plasma,

said cleaning step cleaning said interior of said processing vessel at said second pressure.

18. The cleaning method as claimed in claim 17, characterized in that said step of increasing said total pressure of said mixed gas comprises a step of changing a conductance of said evacuation system and a step of changing a flow rate of said mixed gas.

19. The cleaning method as claimed in claim 17, characterized in that said step of changing said total pressure of said mixed gas is conducted by changing a conductance of said evacuation system and a flow rate of said mixed gas simultaneously.

20. The cleaning method as claimed in claim 17, characterized in that said step of changing said total pressure of said mixed gas comprises a step of decreasing a conductance of said evacuation system while maintaining a flow rate of said mixed gas constant, and a step of increasing said flow rate of said mixed gas while maintaining said total pressure constant.

21. The cleaning method as claimed in claim 20, characterized in that said method further comprises a step of increasing said flow rate of said mixed gas while holding said conductance of said evacuation system maximum.

22. The cleaning method as claimed in claim 17, characterized in that said step of changing said total pressure of said mixed gas comprises a step of

switching plural mass flow controllers.

23. The cleaning method as claimed in claim 17, characterized in that said step of increasing said total pressure of said mixed gas is conducted while maintaining said concentration of said cleaning gas in said mixed gas constant.

24. The cleaning method as claimed in claim 17, characterized in that said step of increasing said total pressure of said mixed gas is conducted while changing said concentration of said cleaning gas in said mixed gas.

25. The cleaning method as claimed in claim 17, characterized in that said cleaning step is conducted by setting said concentration of NF_3 in said mixed gas to 50-40%.

26. The cleaning method as claimed in claim 17, characterized in that said mixed gas is supplied

with a flow rate of 100SCCM or less in said plasma ignition step.

27. The cleaning method as claimed in claims 17 - 26, characterized in that said mixed gas contains NF_3 as said cleaning gas and wherein said first pressure is set to 6.65-66.5Pa.

28. The cleaning method as claimed in claim 27, characterized in that said mixed gas contains NF_3, in said plasma ignition step, as said cleaning gas with a concentration of 5% or more but not exceeding 45%.

29. The cleaning method as claimed in claim 27, characterized in that said mixed gas contains NF_3, in said plasma ignition step, as said cleaning gas with a concentration of 10% or more but not exceeding 45%.

30. The cleaning method as claimed in claim

m 27, characterized in that said mixed gas contains NF_3, in said plasma ignition step, with a concentration of 20% or more but note exceeding 45%.

31. The cleaning method as claimed in claim 17, characterized in that said mixed gas contains F2 as said cleaning gas, and wherein said first pressure is set to 6.65 - 66.5Pa.

32. The cleaning method as claimed in claim 31, wherein said mixed gas contains F_2, in said plasma ignition step, as said cleaning gas with a concentration of 5% or more but not exceeding 45%.

33. A substrate processing method in a processing vessel evacuated by an evacuation system and coupled with a remote plasma source,

characterized in that said remote plasma source comprises a toroidal plasma generator comprising a gas passage having a gas entrance and a gas outlet and forming a circuitous path, and a coil would around a part of said gas passage,

said substrate processing method comprising the steps of:

forming radicals containing F in said remote plasma source; and

etching a surface of a substrate to be processed in said processing vessel by said radicals by supplying said radicals to an interior of said processing vessel,

said step of forming said radicals comprising the steps of:

supplying a mixed gas containing NF_3 or F_2 in an Ar gas with a concentration of at least 5% to said gas passage under a first pressure in which ignition of plasma is possible and igniting plasma by driving said coil with a high-frequency power; and

increasing a total pressure of said mixed gas in said passage to a second pressure while maintaining said plasma,

said step of etching being conducted under said second pressure.

34. The substrate processing method as claimed in claim 33, characterized in that said step of increasing said total pressure of said mixed gas comprises a step of changing a conductance of said evacuation system and a step of changing a flow rate of said mixed gas.

35. The substrate processing method as

claimed in claim 33, wherein said step of changing said total pressure of said mixed gas is conducted by changing a conductance of said evacuating system and a flow rate of said mixed gas simultaneously.

36. The substrate processing method as claimed in claim 33, characterized in that said step of changing said total pressure of said mixed gas comprises a step of decreasing a conductance of said evacuation system while maintaining a flow rate of said mixed gas constant, and a step of increasing said flow rate of said mixed gas while maintaining said total pressure constant.

37. The substrate processing method as claimed in claim 36, characterized in that said method further comprises a step of increasing said flow rate of said mixed gas while holding said conductance of said evacuation system maximum.

38. The substrate processing method as claimed in claim 33, characterized in that said step of changing said total pressure of said mixed gas comprises the step of switching plural mass flow

controllers.

39. The substrate processing method as claimed in claim 33, characterized in that said step of increasing said total pressure of said mixed gas is conducted while maintaining said concentration of said etching gas in said mixed gas constant.

The substrate processing method as claimed in claim 33, characterized in that said step of increasing said total pressure of said mixed gas is conducted while changing said concentration of said etching gas in said mixed gas.

41. The substrate processing method as claimed in claim 33, characterized in that said etching step is conducted by setting said concentration of NF_3 in said mixed gas to 50-40%.

42. The substrate processing method as claimed in claim 33, characterized in that said mixed

gas is supplied in said plasma ignition step with a flow rate of 100SCCM or less.

43. The substrate processing method as claimed in claim 33, characterized in that said mixed gas contains NF_3 as said etching gas, and wherein said first pressure is set to 6.65 - 66.5Pa.

44. The substrate processing method as claimed in claim 43, characterized in that said mixed gas contains NF_3 in said plasma ignition step as said etching gas with a concentration of 5% or more but not exceeding 45%.

45. The substrate processing method as claimed in claim 43, characterized in that said mixed gas contains NF_3 as said etching gas in said plasma ignition step with a concentration of 10% or more but not exceeding 45%.

46. The substrate processing method as

claimed in claim 43, characterized in that said mixed gas contains NF_3 as said etching gas in said plasma ignition step with a concentration of 20% or more but not exceeding 45%.

47. The substrate processing method as claimed in claim 33, characterized in that said mixed gas contains F_2 as said etching gas and wherein said first pressure is set to 6.65 - 66.5Pa.

48. The substrate processing method as claimed in claim 47, characterized in that said mixed gas contains F_2 as said etching gas in said plasma ignition step with a concentration of 5% or more but not exceeding 45%.

49. A cleaning method for cleaning an interior of a processing vessel by plasma-excited radicals of a cleaning gas under a first pressure zone, characterized in that said method comprises the steps of:

introducing a mixed gas of a diluting gas and a cleaning gas to a plasma generator under a second pressure lower than said first pressure and

igniting plasma; and

increasing a pressure inside said processing vessel to said first pressure zone from said second pressure zone.

50. The cleaning method as claimed in claim 49, characterized in that said cleaning gas contains a halogen compound.

51. The cleaning method as claimed in claim 49, characterized in that said cleaning gas contains NF_3.

52. The cleaning method as claimed in claim 49, characterized in that said cleaning gas contains F_2.

53. The cleaning method as claimed in claim 49, characterized in that said diluting gas is selected from any of Ar, Kr and Xe.

54. The cleaning method as claimed in claim 49, characterized in that said plasma generator is a toroidal plasma generator.

55. The cleaning method as claimed in claim 49, characterized in that said plasma generator is any one of a capacitive-coupled plasma generator, an induction-coupled plasma generator, an ECR plasma generator, a helicon wave plasma generator, and a microwave cavity plasma generator.

56. A substrate processing method for etching a surface of a substrate to be processed by plasma-excited radicals under a first pressure zone, comprising the steps of:

introducing a mixed gas of a diluting gas and an etching gas into a plasma generator under a second pressure lower than said first pressure and igniting plasma; and

increasing a pressure inside said processing vessel to said first pressure zone from said second pressure zone.

57. The substrate processing method as

claimed in claim 56, characterized in that said etching gas contains a halogen compound.

58. The substrate processing method as claimed in claim 56, characterized in that said etching gas contains NF_3.

59. The substrate processing method as claimed in claim 56, characterized in that said etching gas contains F_2.

60. The substrate processing method as claimed in claim 56, characterized in that said diluting gas is selected from any of Ar, Kr and Xe.

61. The substrate processing method as claimed in claim 56, characterized in that said plasma generator is a toroidal type plasma generator.

62. The substrate processing method as claimed in claim 56, characterized in that said plasma generator is any one of a capacitive-coupled plasma generator, an induction-coupled plasma generator, an ECR plasma generator, a helicon wave plasma generator, and a microwave cavity plasma generator.

63. A cleaning method for cleaning an interior of a processing vessel by plasma-excited radicals of a cleaning gas under a first pressure zone, comprising the steps of:

introducing a mixed gas of a diluting gas and a cleaning gas into a plasma generator under a second flow rate zone smaller than said first flow rate zone and igniting plasma; and

increasing a flow rate of said mixed gas from said first flow rate zone to said second flow rate zone.

64. The cleaning method as claimed in claim 63, characterized in that said cleaning gas contains a halogen compound.

65. The cleaning method as claimed in claim

63, characterized in that said cleaning gas contains NF_3.

66. The cleaning method as claimed in claim 63, characterized in that said cleaning gas contains F_2.

67. The cleaning method as claimed in claim 63, characterized in that said diluting gas is selected from any of Ar, Kr and Xe.

68. The cleaning method as claimed in claim 63, characterized in that said plasma generator is a toroidal plasma generator.

69. The cleaning method as claimed in claim 63, characterized in that said plasma generator is any one of a capacitive-coupled plasma generator, an induction-coupled plasma generator, an ECR plasma generator, a helicon wave plasma generator, and a microwave cavity plasma generator.

70. A substrate processing method for etching a surface of a substrate to be processed in a processing vessel by plasma-excited radicals of etching under a first flow rate zone, comprising the steps of:

introducing a mixed gas of a diluting gas and an etching gas into a plasma generator under a second flow rate zone smaller than said first flow rate zone and igniting plasma; and

increasing a flow rate of said mixed gas from said second flow rate zone to said first flow rate zone.

71. The substrate processing method as claimed in claim 70, characterized in that said cleaning gas contains a halogen compound.

72. The substrate processing method as claimed in claim 70, characterized in that said cleaning gas contains NF_3.

73. The substrate processing method as claimed in claim 70, characterized in that said cleaning gas contains F_2.

74. The substrate processing method as claimed in claim 70, characterized in that said diluting gas is selected from any of Ar, Kr and Xe.

75. The substrate processing method as claimed in claim 70, characterized in that said plasma generator is a toroidal plasma generator.

76. The substrate processing method as claimed in claim 70, characterized in that said plasma generator is any one of a capacitive-coupled plasma generator, an induction-coupled plasma generator, an ECR plasma generator, a helicon wave plasma generator, and a microwave cavity plasma generator.